CSCI–4961/6961 Advanced Robotics
Spring 2000

Instructor:	Prof. Wes Huang
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office:	Amos Eaton 111, x8189
office hours:	TBA (or by appointment)

classroom:	Low (CII) 3045
times:	Monday and Wednesday 2:00 - 3:50pm
prerequisites:	no formal prerequisites, but see below
text:	none (course notes and readings will be handed out)
www:	http://www.cs.rpi.edu/courses/spring00/advrobot (accessible from http://www.cs.rpi.edu/~whuang)

Course description

This course is an introduction to analysis of, and algorithms for robotic systems. We will cover topics in both robotic manipulation and mobile robotics.

The fundamentals of this course are techniques for modeling robotic systems (physics and kinematics), for analyzing systems and formulating solutions (planning algorithms), and for implementation and control of such systems (feedback control). The first part of the course will be devoted to these fundamentals; in the rest of the semester, we will study more specific techniques for robotic manipulation and mobile robotics.

Prerequisites

There are no formal prerequisites for this class. HOWEVER, since robotics is a multidisciplinary field, I will draw from a number of areas listed below. I will not make such extensive use of any one area that I think students need a full course in that area (with the probable exception of programming). The main areas from which I will draw are:

- physics (basic mechanics) — Newton's laws of motion, free body diagrams, friction, energy, momentum, and impact are the ideas used for modeling physical systems
- math (some calculus, differential equations, and linear algebra) for analysis of physical systems, feedback control, robot motion planning, etc.
- computer science (programming, algorithms) — we will be talking about algorithms throughout the class. You should have sufficient programming capability that if you understand an algorithm, you can implement it (and any necessary data structures) in your favorite programming language.
- control theory (basic feedback control) — I won't assume students know much about control theory, but we will be covering the basics. This is where some knowledge of differential equations will come in handy.

Course activities & policies

Revised or updated versions of the course activities and policies will be available on the course home page.

Activities

A project is an integral part of this class and will occupy most of the second half of the semester. Students will form groups of 2–4 students, and propose and execute a final project. Projects may be either hardware based (i.e. a project ultimately involving operation of some physical hardware) or software based (i.e. a project involving simulation or implementation of some algorithm).

Project teams and project topics will be self selected, subject to instructor approval. Each project will be due in two phases, as noted on the schedule. More information regarding the project will be made available later in the semester.

Other course activities include written assignments and reading papers from the robotics literature. There will be 3 or 4 assignments in the first half of the semester, and we will read approximately 6 research papers from the robotics literature; a 0.5–1 page reading report will be due on each paper. We will split the class into 2 sections on the "reading discussion day" for a 1 hour discussion (one at 2:00, the other at 3:00). Two or three students will be asked to present a paper in each discussion section and help lead the discussion. (Each student should present once during the semester.)

You should come to the discussion sections prepared to participate in a discussion of the paper for that day.

Grading

Your grade will be (tentatively) determined as follows:

25%	Assignments
25%	Reading reports and discussion sections
50%	Project

Academic honesty

I encourage you to discuss readings and assignments with others. However, I expect that any assignment or reading report that you turn in to be your own work — the product of your understanding of the course material and your effort in completing the work.

The Rensselaer Handbook of Student Rights and Responsibilities defines several types of academic dishonesty, all of which are applicable to this class. Students found in violation of academic dishonesty policies may receive a failing grade for this course.

Please contact the instructor if there is any question about academic (dis)honesty. This information will be clarified as necessary during the course.

Late policy

Late work places an additional burden on the teaching staff and is unfair to those students who turn in their work on time.

Unless you make *prior* arrangements with the instructor, assignments and reading reports are due at the beginning of class (2:00 pm) on the day they are due. Assignments turned in up to 48 hours late will be assessed a 10% penalty. After 48 hours, assignments

will be assessed a 20% penalty. Late assignments and reading reports will not be accepted after a week past the due date. Similar late penalties will apply to the project.

Attendance

You are responsible for knowing all material covered in class. If you should miss a class, please contact a classmate first to learn what was covered that day. We will attempt to keep the revised syllabus on the course home page up to date. You should attend all reading discussion sections. (I will reserve the right to take attendance at reading discussion sections and consider this in determining your grade for that portion of the class.)

Tentative schedule

Week				Topic	Readings/Assignments/Project
1	M	Jan	10	Introduction, Planar kinematics	
	W		12	Physics, friction How to read a research paper	
2	M		17	NO CLASS	
	W		19	Configuration space, classical planning	Assignment 1 due
3	M		24	Feedback control	Reading report 1 due
	W		26	Discuss Reading 1	
4	M		31	Feedback control	Assignment 2 due
	W	Feb	2	Introduction to mobile robotics	
5	M		7	Mobile robot basics	Reading report 2 due
	W		9	Discuss Reading 2	
6	M		14	Localization, uncertainty, estimation	Assignment 3 due tentative project groups due
	W		16	Localization, uncertainty, estimation	
7	M(T)		22	Nonholonomic path planning	Reading report 3 due preliminary project proposals due
	W		23	Discuss Reading 3	
8	M		28	Navigation	final project proposals due
	W	Mar	1	Navigation	
9	M		6	Mobile robot architectures	Reading report 4 due
	W		8	Discuss Reading 4	
				SPRING BREAK!	
10	M		20	Guest lecture	
	W		22	Pushing, tapping	
11	M		27	Grasping, force & form closure	Reading report 5 due
	W		29	Discuss Reading 5	Project phase 1 due
12	M	Apr	3	Guest lecture	
	W		5	NO CLASS!	
13	M		10	Guest lecture	Reading report 6 due
	W		12	Discuss Reading 6	
14	M		17	Project presentations	
	W		19	Project presentations	
15	M		24	Project presentations	
	W		26	TBA	Project phase 2 due